

**Optimal New Product Preannouncement Timing  
in Competitive Markets**

by

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## ABSTRACT

New products are essential for companies to survive. These companies apply different strategies for the new product to be successful in the markets. New product preannouncement is one of these strategies. It differs from other strategies taking place before the product's physical availability. New product preannouncement can be very beneficial for the product; however, companies should be careful with its timing because wrongly made preannouncement may harm the company as well. We examined the optimal new product preannouncement timing in this thesis analyzing a stylistic model of preannouncement for monopoly and duopoly cases. In the monopoly case, the incumbent firm has an existing product and intends to launch a more profitable, higher quality new product to the market. The same number of customers join the market each period. We found that the company should preannounce the new product immediately since it has a higher profit. In the duopoly case, a new company preannounces its new product to similarly shaped market as the monopoly case. Our findings showed that the incumbent firm should preannounce either immediately after the innovator announces or at the same time as the innovator launches its product. Higher quality difference between the incumbent's existing and new products, later innovator launch and smaller converting rate to the innovator lead the company to preannounce immediately. Then, we examined the market with discounting and found out that higher discounting factors lead the company to preannounce later. If the innovator may not launch its new product, this unreliability leads the incumbent company to preannounce immediately. Finally, we ran a laboratory experiment independently from the analytical model. This experiment did not fully support the model which directs us to the future research. The results indicates the lack of human factor in the analytical model.

Yeni ürünler şirketlerin hayatlarına devam edebilmeleri için çok önemlidir. Bu şirketler yeni ürünlerinin başarılı olabilmesi için farklı stratejilere başvururlar. Yeni ürün önduyurusu bu stratejilerden bir tanesidir. Ürünün markette yerini almadan vuku bulmasıyla diğer stratejilerden ayrılır. Yeni ürün önduyurusu şirketler için çok faydalı olabilmektedir; ancak, bu şirketler önduyurunun zamanı konusunda dikkatli olmalıdır. Yanlış yapılmış önduyuru şirkete zarar verebilir. Bu tezde önduyuru için en iyi zamanın bulunması konusunu çalıştık. Bir monopolide, baskın şirket pazarda bir ürüne sahiptir ve daha kaliteli, daha karlı yeni bir ürün çıkarmayı planlamaktadır. Bulgularımız bu şirketin yeni ürününü daha karlı olmasından dolayı hemen duyurması gerektiğini göstermektedir. Duopoli market monopoliden daha karmaşıktır. Pazara yeni bir şirket girer ve yeni ürününü duyurur. Bulgularımız baskın şirketin yeni ürününü hemen ya da yeni şirketin ürününü çıkartacağı zamanda duyurması gerektiğini göstermektedir. Baskın şirketin pazardaki ve yeni ürünleri arasındaki yüksek kalite farkı, yeni şirketin daha geç ürün çıkarması ve yeni şirketi tercih eden daha az sayıda insan olması baskın şirketi hemen duyuru yapmaya itmektedir. Faiz oranının varlığı baskın şirketi daha geç önduyuru yapmaya itmektedir. Bir sonraki kısımda, pazara yeni giren şirketin güvenilir olmaması durumunu inceledik. Bu güvensizlik baskın şirketi hemen duyuru yapmaya itmektedir. Son olarak, matematiksel modelimizden bağımsız olarak bir laboratuvar deneyi tasarladık. Deney sonuçları modeli tam olarak desteklememekle birlikte gelecek çalışmalar için bize yol gösterdi. Sonuçlar modelde insan faktörünün eksikliğini göstermektedir.

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## 1. INTRODUCTION

Launching new products successfully is crucial for companies but it is a complex and difficult task [2]. Companies develop different strategies to capture higher market shares. One of the most important strategies is preannouncement [7]. Preannouncement is a formal, deliberate communication before a firm actually undertakes a particular marketing action such as price change, a new advertising campaign, launching a new product or a product line change [5]. A new product preannouncement includes firms formal efforts to inform the customers of the future availability, quality, and the introductory price of the new products [11]. Unlike other marketing communications, it takes place before product launch to prepare different audiences psychologically before physical availability about the new product [4]. These audiences are present and potential consumers, rivals, collaborators such as retailers, shareholders, financial community and sub-companies mostly. A new technology can get adopted more easily with the presence of preannouncement [6].

Companies preannounce their products routinely. For instance, Bill Gates officially announced Microsoft X-Box in March 2000, even though the game console was not due to be released before Fall 2001 (Business Week, 2000). In the same product category, Sony announced the PlayStation 2 twelve months before launching it in Japan (The Economist, 1999). Apple and Samsung organize events to announce their new cell phones and tablet PCs a couple of times a year. Those companies give information about the new product such as its qualifications, price, launch date and in which countries it will be available. Lastly, Apple organized an event to introduce the new MacBook and Apple Watch a month before their launches last year although the company preannounced the products much before that date. Not only technology based companies but also firms in other industries such as automotive, entertainment and fashion have started to preannounce their new products lately. For instance, car producers preannounce their new models months before they get available on the market.

Companies use different channels to preannounce new products. Most of the technology based companies organize events to show their new products and give information about them. Trade shows are used extensively in the automotive sector. Car producers introduce their new models and concept products in the automobile fairs with spectacular shows. Media channels are other important ways for those companies. Fashion brands use fashion parades, mostly. Another popular channel is business oriented magazines for many brands.

Preannouncements may be very beneficial. A preannouncement enables the potential customers

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to get prepared for the new product [10]. Customer awareness increases and customers delay their purchases until the new product is available [12]. It gives information about the new product and this information reduce the functional, economic, social or psychological risks of the customers [14]. Preannouncement increases customer curiosity and interest in the new product [11]. Lastly, it gives extra time to the customers to plan so switching costs decrease [10].

Preannouncement may have disadvantages, though. Early preannouncement leads the customers to have little interest to learn about the new product or to delay their purchases. The rivals can get alerted by the preannouncement. More importantly, the current product may be cannibalized if the customers stop buying it [10]. The company should be careful with what it promised because delayed products may harm the company's reputation.

This research builds on the existing literature on new product preannouncement to explore the optimal preannouncement time. An important topic about preannouncement is its timing. A new product can be preannounced days, months, even years before its launch and this time interval can affect the sales significantly [11]. However, this topic has been studied poorly. Lilly and Walters [11] and Kohli [10] are early papers studying the basics of new product preannouncement timing. Su and Rao [18] is a late paper studying time interval between preannouncement and launch analytically. What we contribute to the literature with this study is to find out the optimal timing of preannouncement for a company under competition. There is competition between the firms because the number of total customers is stable and those companies try to convert the customers to their own products. The models we present can be used by monopolistic or duopolistic firms where the assumptions are applicable. Future works will be more suitable for real life firms to use. We present the review of the current literature in Section 2. We analyze the monopoly, duopoly with and without discounting and duopoly with an unreliable firm in Sections 3, 4, and 5 and present models to find out the optimal preannouncement timing for these cases. We present the experimental studies about new product preannouncement and its results in Section 6. Lastly, we present the conclusion in Section 7.

## 2. LITERATURE REVIEW

Our review shows that new product preannouncement has a small but growing literature. Early studies were founded on interviews with industry managers and mainly about basics of new product preannouncement. Later, there have been studies about preannouncement content, preannouncement advantages and disadvantages; and preannouncement risks and effects on the firms, consumers and markets. Lastly, analytical and game theoretical models have been developed to find out the issues such as the time interval between preannouncement and launch and preannouncement consequences under different cases. Preannouncement timing has been poorly studied and the papers about it are more likely conceptual ones. We developed an analytical model to suggest an optimal time to preannounce for a firm under different cases and we ran an experiment to show peoples purchase decisions under different conditions.

Eliashberg and Robertson [5] is one of the earliest studies on new product preannouncement. They administered a questionnaire among firms some of which that had preannounced and some of which had not preannounced their new products. They defined preannouncement as a formal, deliberate communication before a firm actually undertakes a particular marketing action such as price change, a new advertising campaign, launching a new product or a product line change.

Ofek and Turut [13] identify three different preannouncement strategies: Vaporware strategy, trueware strategy and suddenware strategy. Vaporware is the strategy that the incumbent firm (the firm that already has a product on the market) always preannounces the new product regardless of the actual development plans. Trueware is the strategy that the incumbent firm preannounces the new product only if its actual plan is to do so. Lastly, suddenware is the strategy that the incumbent stays silent regardless of the actual development plans.

### *2.1. Antecedents and Consequences of Preannouncement*

Lilly and Walters [11] showed the most likely reasons of preannouncement which are to build interest, to encourage purchase delay for the existing products, to test the new products design and forecast and to keep the special customers updated; and the most likely reasons to consider before preannouncement which are customer confusion, interdepartmental frustration, competitive learning, the new product isnt new anymore and the probability of not launching the product on time.

Preannouncement activities get affected by various factors. There are strong inverse relations be-

tween likelihood of preannouncing behavior and the firms market dominance level as well as likelihood of preannouncing behavior and the firms total size (Eliashberg and Robertson, 1988) [5]. Preannouncement may also change based on the consumer profile. There is a positive relationship between likelihood of preannouncing behavior and the level of costumer switching costs which covers the purchase cost of the new product and all the related costs of changing the production and consumption system [5]. When consumer learning requirements increase, the company is more likely to preannounce.

Preannouncement is a very important factor for both companies and markets. It has effects on company value, market size and competition. Preannouncement effects may last for a long term as well as for a short term (Assayag et. al, 2001) [1]. Sorescu et al. [17] stated that preannouncement may lead to financial returns to the firm in the short and the long run. They pointed out that preannouncements including more information about the product bring greater short-term returns analyzing short and long-term stock returns data from computer hardware and software industries. Likely, more reliable firms preannouncements bring greater short term returns. The firm can update the information in a preannouncement and these results bring greater long term returns.

Preannouncement can specify industry standards (Farrell and Saloner, 1986) [6]. Bayus et. al. [3] indicated that preannouncement leads to higher total expected duopoly profits using a game theoretical model. If the dominant firm preannounces its new products launching time, the other firm can save up not developing a new product any more in case the dominant firm has low development costs. However, if the dominant firm doesnt preannounce, the other firm may enter the market and lose its investment in the same case.

## 2.2 Advantages and Disadvantages of Preannouncement

Eliashberg and Robertson [5] stressed out that preannouncement would be beneficial especially for technology based companies. This paper points out that there are benefits of preannouncement stressed out by the preannouncing firms and risks of preannouncement stressed out by the non-preannouncing firms and these benefits and risks may change from one environment to another.

New product preannouncement may be very advantageous for the firms. Preannouncements affect consumer decisions. Consumers may prefer to wait and purchase the preannounced product or purchase the existing product (Greenleaf and Lehmann, 1995) [8]. By preannouncing, companies can educate potential consumers and encourage them to wait for the new product until it becomes available instead of buying the existing product (Greenleaf and Lehmann, 1995; Eliashberg and Robertson, 1988; Lilly and Walters, 1997; Mishra and Bhabra, 2001) [5] [8] [12] [11]. Lastly, when the firm preannounces to the potential buyers, the relations between buyer, product and firm will be stronger (Lilly and Walters, 1997) [11].

On the other hand, a company should be careful with the preannouncement since it has disadvan-

tages, too. Announcement about a new product can awake competitors (Robertson et al, 1995) [16]. Companies should keep the word they gave. The consequences may be harsh if they delay the time they announced. If a company cannot keep its announcement promise, its reputation may decrease. Wu et al. [19] focused on the cases when the firm delays the new product. They highlighted that delay announcements, on average, decreases the firms market value by 5.25 percent. They pursued an empirical analysis with the data collected from executives in the industries to explain the potential reasons of new product launch delays. The firm using the preannouncement strategy as a competitive tool delays the launch more likely.

Cannibalization and not-delivering the preannounced product in time as promised are the riskiest results of preannouncement. Su and Rao [18] identify two types of cannibalization: new product launch cannibalization and new product preannouncement cannibalization. New product launch cannibalization is caused by buyers stopping buying the existing product and starting buying the new product. New product preannouncement cannibalization is caused by pent-up demand which is the buyers commitment to buy the new product before its launch and has a cost, called new product preannouncement cost for the firm. The company should consider the cannibalization effect if the existing product is a substitute one [10]. Unlike the previous research, Rao and Turut [15] stated that cannibalization may be good for the firm if the new product is profitable since the higher margin product is more profitable than the lower margin product for a monopolist firm.

### 2.3 Preannouncement Timing

The time and time interval between preannouncement and launch are very important decisions. However, this topic has been poorly studied. Kohli [10] identifies preannouncement timing as the interval between the first communication about the product and the launch of the product. He states that preannouncement timing is related to product, design and industry based on an empirical analysis. Lilly and Walters [11] offered a model of the factors influencing the preannouncement timing based on interviews with managers from different industries.

Another important topic is when to preannounce the new product. It can be done earlier or later in different cases. Early papers in this stream are conceptual papers stating the factors affecting the preannouncement timing. The company should preannounce the new product later if the potential damage of the preannouncement such as cannibalization is higher or the preannouncement prevents the development of the new product. Moreover, if the new product is more innovative or more complex, the company should preannounce it earlier to educate the buyers. Higher switching costs and longer buying processes lead to early preannouncement, too. Lastly, as the buyer loyalty increases, preannouncement timing gets backward (Kohli, 1999; Lilly and Walters, 1997) [11] [10].

Su and Rao [18] is one of the most recent papers on new product preannouncement studying the

optimal preannouncement and launch timing decisions under competition with a game theoretical model when the firms decide simultaneously and sequentially. They tried to find out preannouncement's effects on demand and on cannibalization of the existing product as well as preannouncement and launching times of a new product and factors affecting these. The model in this paper is based on new product preannouncement cost in a duopoly market where both firms have existing products and intend to launch new products. They offer time intervals between preannouncement and launch for both the market leader firm and the follower firm. The results indicate that in a sequential game, the leader firm should preannounce closer to the launch of the new product unless a threat comes from the follower firm. However, the same leader firm should preannounce earlier in a simultaneous game because it loses the advantage of choosing first. Another result is that the leader gets higher total profit in a sequential game than a simultaneous game.

#### 2.4 Key Papers for Our Study

Rao and Turut [15] and Ofek and Turut [13] are the papers that we borrowed our basic assumptions from. Those two papers are discussed in detail below.

Rao and Turut [15] focused on the consequences of new product preannouncement based on consumers context dependent preferences for monopoly and duopoly markets. In the model, there are two types of customers: the ones who are willing to pay for extra quality and the ones who do not. Quality valuations are different for these customer types. In the model, customers choose between buying the lower quality existing product and waiting for the higher quality new product. Preannouncement affects a certain proportion of those customers and the affected ones wait for the new product. There are two models in this paper: the first model analyzes the markets when there is no context dependency i.e, when there is no loss aversion. (In the existence of loss aversion, consumer's utility covers gains and losses of each attribute compared to a reference point and losses affect the total utility more than gains.) The second model analyzes the markets when there is context dependency. The first model indicates that the monopolist firm should preannounce the new product in every case when there is no loss aversion of the customers. In a duopoly, the lower quality firm preannounces its new product in every case, too. However, there is a threshold based on the quality valuations of different customer types for the higher quality firm. This model indicates that if the loss sensitivity of the customers is higher than a certain point, the monopolist firm shouldnt preannounce. This means that the monopolists preannouncement incentive decreases with context dependency. A similar result is valid for a duopoly market. Lower quality and higher quality firms make their preannouncement decisions depend on certain loss sensitivity points of the customers. Similar to the monopoly case, the lower quality firms preannouncement incentive decreases with context dependency. However, the higher quality firms preannouncement incentive increases with context dependency.

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Ofek and Turut [13] is one of the most recent papers on preannouncement examining the issue under market uncertainty. They developed a model for the incumbent firm (the firm that already has a product on the market) to decide which preannouncement strategy to pursue in a duopoly market among vaporware strategy, trueware strategy and suddenware strategy (those strategies are identified in Section 2.1). In the model, the incumbent and innovative (newcomer) firms get noisy private signals about the new product and the market prior to the launch affecting their assessments of the new products market potential. The new product may bring high or low commercial rewards with a certain probability and the firms may pursue or forgo the new product. The game covers 4 periods. Firms receive the signals in the first period, the incumbent firm decides on the new product investment and preannouncement strategy in the second period, the new comer decides on the new product investment in the third period, and consumers enter the market in the last period. They assume that the innovative firm launches its new product when the signal is high and gives up on the product when the signal is low. At first sight, vaporware strategy may seem attractive to the incumbent firm to keep the innovative firm away from the market. However, the incumbent firm should stay silent in case its market signal is low and the firm decides to forgo on the product. On the other hand, when the market signal is high and the incumbent firm intends to develop the new product, the incumbent firm should preannounce this product to increase the demand. The point shown for the innovative firm is that when the incumbent firms signal is reliable, suddenware is the preferred strategy for the innovative firm meaning this firm should stay silent; but when the incumbents signal is not very reliable, the innovative should rely on its own signal and vaporware should be the preferred strategy meaning that it should preannounce its product. Lastly, the innovative may want to postpone its development plans since information about the incumbent may leak out in time.

Tab. 2.1: Literature Table

| Name                       | About                                                                                                                                             | Method                                                                                |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Assayag et. al, 2001 [1]   | This paper analyzes whether preannouncements impact is limited to the launch period or if it can have long term consequences.                     | A model to estimate the impact on the long term market penetration of the new product |
| Bayus et. al, 2001 [3]     | The focus of this article is a firms use of preannouncement in telling potential competitors about its new product development efforts.           | Game theoretical model                                                                |
| Eliasberg et. al, 1988 [5] | On of the earliest studies on new product preannouncement. They presented the basics of preannouncement.                                          | Survey                                                                                |
| Kohli, 1999 [10]           | He studied preannouncement timing's basics and focused on cannibalization.                                                                        | Conceptual                                                                            |
| Lilly et. al, 1997 [11]    | They presented the reasons and results of preannouncement and its timing.                                                                         | Conceptual                                                                            |
| Ofek et. al, 2013 [13]     | They presented three different preannouncement strategies and developed a model in which an incumbent firm needs to decide which strategy to use. | Analytical model                                                                      |
| Rao et. al, 2013 [15]      | They focused on the consequences of new product preannouncement based on consumers' context dependent preferences.                                | Analytical model                                                                      |
| Sorescu et. al, 2007 [17]  | The primal purpose of this article is to examine the relationship between new product preannouncement and firm value.                             | Risk adjusted models using data from computer software and hardware industries        |
| Su et. al, 2011 [18]       | They studied the optimal timing decisions for preannouncement and launch under competition.                                                       | Game theoretical model                                                                |
| Wu et. al, 2004 [19]       | They presented a framework that explains delays in preannouncements.                                                                              | Interviews with managers                                                              |

### 3. PREANNOUNCEMENT IN A MONOPOLISTIC MARKET

#### 3.1 *Monopolistic Market Case without Discounting*

This section considers a market dominated by an incumbent firm and derives the optimal timing for the preannouncement of a novelty developed by this firm. The firm has an existing product in the market, which is joined by a constant number of customers in each period  $t = 1, 2, \dots$ . This number is normalized to one without loss of generality. This assumption is similar to Ofek and Turut [13]. Customers only know what the companies share with them and they do not know the company's capability of producing the new product with the announced quality or on time. Currently, the firm is working on a new product, which it estimates to launch after  $N \geq 2$  periods from now. Once launched, the new product will replace the existing one and the firm will cease to produce the existing product. This strategy of the firm is known as *Product Replacement Strategy* in the marketing literature. The firm expects that the unit production cost and the unit selling price will increase proportionally to the quality increment with the introduction of the novelty. That is, if  $q > 0$  denotes the quality of the existing product and  $q + \delta$  that of the new product, with  $\delta > 0$ , the new product will generate an additional profit of  $\pi\delta$  per unit sale, where  $\pi > 0$  is the profit per unit quality. The question is whether the firm should preannounce the new product in any period  $n = 1, \dots, N - 1$  before making it available in the market. If the firm does not preannounce it, then all customers that join the market before period  $N$  buy the existing product, as it is the only alternative that they know of. If the firm preannounces in period  $1 \leq n \leq N - 1$ , then a proportion  $0 < f(t, N) \leq 1$  of the customers who join in period  $t \geq n$  defer their purchase to buy the new product while the remaining proportion  $1 - f(t, N)$  buy the existing product. The Product Replacement Strategy requires that  $f(t, N) = 1$  for  $t \geq N$ . Also it is natural to assume that the function  $f(t, N)$  increases as the gap between  $t$  and  $N$  decreases, since approaching the launch reduces the ambiguity about the new product. Figure 3.1 shows the timetable for the monopoly case.

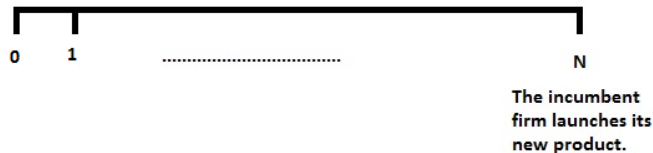


Fig. 3.1: Timetable for the Monopoly Case

The following is a summary of the model parameters and assumptions.

We assume that the same number of customers join the market each period. We normalized this number to 1 for simplification.

The firm profit is  $\pi > 0$  per unit quality.

The firm will launch the new product after  $N \geq 2$  periods from now.

The existing product has quality  $q > 0$  and the new product has quality  $q + \delta$  with  $\delta > 0$ .

If the new product is preannounced before period  $t$ , the proportion  $f(t, N)$  of the customers who join the market in period  $t$  buy the new product while the rest buy the existing product.

In order to derive the optimal preannouncement strategy, let  $S_t(n)$  denote the sales (in quality units) generated in period  $t$  if the firm preannounces in period  $1 \leq n \leq N$ , where  $n = N$  represents the case without preannouncement. For  $t \geq n$ , the new product sales are included in  $S_t(n)$  even though they are actualized when the product is launched in period  $N$ . Accordingly,

$$S_t(n) = \begin{cases} q & \text{if } t < n, \\ q + f(t, N)\delta & \text{if } t \geq n. \end{cases} \quad (1)$$

Since  $f(t, N) = 1$  for  $t \geq N$ , under any preannouncement strategy  $1 \leq n \leq N$ ,  $S_t(n) = q + \delta$  for  $t \geq N$ ; therefore to maximize its profit, the incumbent needs to consider only the profit from the sales generated over periods  $t = 1, \dots, N - 1$ . The  $(N - 1)$ -period profit  $U(n)$  of the firm if it preannounces in period  $n$  is

$$U(n) = \pi \sum_{t=1}^{N-1} S_t(n). \quad (2)$$

The following theorem establishes the optimal preannouncement strategy for the incumbent firm.

**Theorem 1:** The unique optimal preannouncement strategy of the incumbent firm operating in a monopolistic market is to preannounce immediately.

**Proof.** For  $1 \leq n \leq N - 1$ ,  $S_t(n + 1) = S_t(n)$  for  $1 \leq t \leq n - 1$  and  $t \geq n + 1$  by (1). Using this and (2), the profit loss from deferring the preannouncement for one period can be expressed as

$$U(n + 1) - U(n) = \pi \sum_{t=1}^{N-1} [S_t(n + 1) - S_t(n)] = \pi [S_n(n + 1) - S_n(n)] = -\pi f(n, N) < 0,$$

so  $U(N) < U(N - 1) < \dots < U(2) < U(1)$  and preannouncing immediately is the unique optimal strategy.  $\square$

The result stated in Theorem 1 is intuitive and rather trivial. Since the new product is assumed to be more profitable than the existing one, the firm should preannounce it as soon as possible in order to convert the largest possible proportion of the demand for the existing product to the new product. The results indicate that a monopolistic firm (like big monopolistic software companies or monopolistic game companies in some countries) should preannounce their new products as soon as they know when the new product will be ready to be launched. A more interesting case occurs when there are multiple firms in the market. The competitive market is analyzed in the following section.

### 3.2. Monopolistic Market Case with Discounting

This section introduces the same monopoly market as in Section 3.1 with discounting factor existence. In this case, the firm's income increases in value by  $\rho$  in time ( $0 \leq \rho < 1$ ). Only the existing product's income gets affected by this discounting factor since the new product brings money only after it gets launched. In the following we present the sales ( $S_t(n)$ ):

$$S_t(n) = \begin{cases} q & \text{if } t < n, \\ (1 - f(t, N))q + f(t, N)(q + \delta)\rho^{N-t} & \text{if } t \geq n, \end{cases} \quad (3)$$

$$U(n) = \pi \sum_{t=1}^{N-1} \rho^t S_t(n). \quad (4)$$

$$f(t, N) = \frac{t\beta}{N}, \quad (5)$$

where  $0 < \beta \leq 1$  is constant. The following theorem characterizes the optimal preannouncement timing for the monopolistic firm:

**Theorem 2:** In a monopolistic market, where the firm will launch a new product after  $N \geq 2$  periods from now, an optimal preannouncement strategy of the firm is to preannounce immediately if

$$\frac{q}{\delta} \leq \sum_{n=1}^{N-1} \frac{\rho^{N-n}}{1 - \rho^{N-n}},$$

$$(6)$$

and not to preannounce if

$$\frac{q}{\delta} \geq \sum_{n=1}^{N-1} \frac{\rho^{N-n}}{1 - \rho^{N-n}}. \quad (7)$$

In this theorem, there is a threshold for  $\frac{q}{\delta}$ .  $q$  represents the quality of the firm's existing product and  $\delta$  represents the quality difference between the firm's existing and new products. The theorem indicates that if the proportion of the existing quality and the quality difference is greater than or equal to the right hand side, the firm should not preannounce the new product; if this proportion is less than or equal to the right hand side, the firm should preannounce immediately.

**Proof.** The change in the firm's profit when it preannounces in period  $n + 1$  rather than  $n$  is

$$U(n + 1) - U(n) = \pi \left[ \sum_{t=1}^{N-1} \rho^t (S_t(n + 1) - S_t(n)) \right],$$

which reduces to

$$U(n + 1) - U(n) = \frac{n\beta\rho}{N} [q(1 - \rho^{N-n}) - \delta\rho^{N-n}]$$

after rearranging the terms. This expression is non-positive if the the inside of the bracket is non-positive. So, this expression is non-positive if  $q(1 - \rho^{N-n}) - \delta\rho^{N-n} \leq 0$ . Followingly,

$$\frac{q}{\delta} \leq \sum_{n=1}^{N-1} \frac{\rho^{N-n}}{1 - \rho^{N-n}}$$

This completes the proof of the theorem.  $\square$

## 4. PREANNOUNCEMENT IN A DUOPOLISTIC MARKET

### 4.1 *Duopolistic Market Case without Discounting*

This section introduces a new firm to the market. As in Chapter 3, the incumbent firm has an existing product in the market and is currently working on a new product that will be launched after  $N \geq 2$  periods from now. We refer to the second firm as the innovator. This firm does not have any products in the market at present; however, it has just preannounced the new product with which it will enter the market after  $1 \leq R < N$  periods from now. This section assumes that the innovator is completely reliable in the sense that its product will indeed be in the market at the promised time. The question for the incumbent firm is again whether to preannounce its new product in any period or not.

The market demand follows the same pattern as in the monopolistic setting, i.e., one customer joins the market in every period; however, now it is divided between the incumbent and the innovator. The division of demand between the two firms is based on the assumption that conversion to a new product occurs only when customers are exposed to new information. The exposition of a customer to new information in a period can be in two ways: either the customer joins the market in that period or the incumbent firm preannounces its new product in that period. Consequently, the main difference from the monopolistic setting is that if the incumbent preannounces before the innovator launches its product, customers who chose to wait for the innovator before this period can revise their decision and decide to wait for the incumbent's new product.

Let  $n \in \{1, \dots, N\}$  denote the period in which the incumbent preannounces,  $0 < f(t, N) \leq 1$  for  $t < N$  and  $0 \leq g(t, R) \leq 1$  for  $t < R$  be the conversion rates of the incumbent and the innovator, respectively. We assume that once the innovator launches its product, its market share stabilizes at rate  $0 \leq \alpha \leq 1$  and once the incumbent launches its new product, it does not produce the existing product and the market share of its new product stabilizes at rate  $1 - \alpha$  unless there is new information on the market. Preannouncement strategies available to the incumbent and resulting demand are detailed below. As in Section 1, let  $S_t(n)$  be the sales (in quality units) that the incumbent generates in period  $t$  if it adopts the preannouncement strategy  $1 \leq n \leq N$ .

Not preannounce:  $n = N$ . For  $t < R$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product. For  $R \leq t < n = N$ , the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the

rest buy the incumbent's existing product. For  $t \geq n = N$ , the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product. Figure 4.1 shows the timetable for the duopoly case when the incumbent does not preannounces before  $t = N$ .

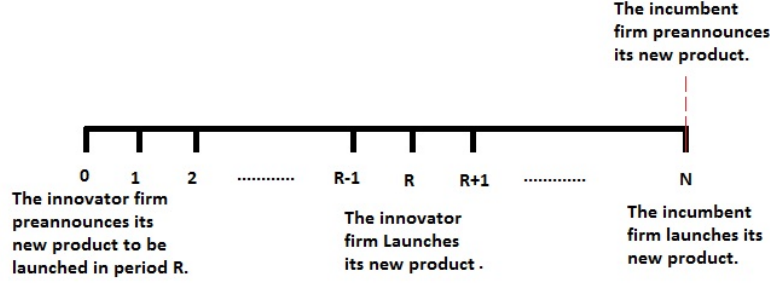
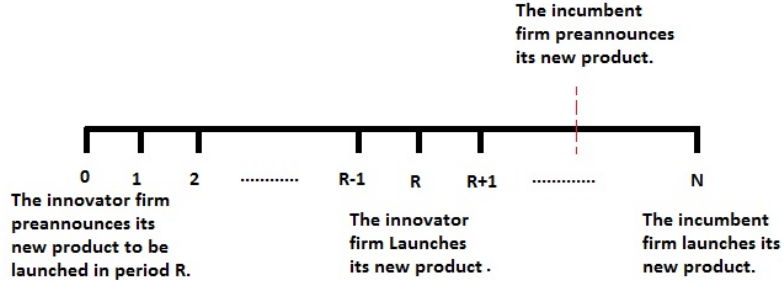


Fig. 4.1: Timetable for the Duopoly Case When the Incumbent doesn't Preannounce

Accordingly,

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < R, \\ (1 - \alpha)q & \text{if } R \leq t < n, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq n. \end{cases} \quad (1)$$

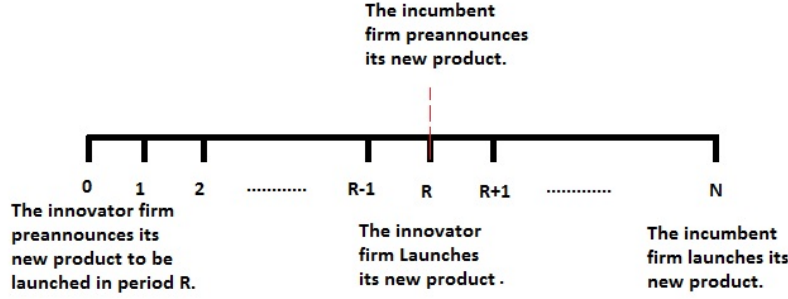
Preannouncement after innovator launches:  $R < n < N$ . In this case, the customers who prefer the innovator cannot be converted, since the innovator's product is already in the market until the incumbent preannounces. For  $t < R$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product. For  $R \leq t < n$ , the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product. For  $n \leq t < N$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)]\alpha$  of customers who join the market in period  $t$  buy the innovator's product, and the rest buy the incumbent's existing product. For  $t \geq N$ , the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product. Figure 4.2 shows the timetable for the duopoly case when the incumbent preannounces after the innovator launches.

Fig. 4.2: Timetable for the Duopoly Case When the Incumbent Preannounce after  $R$ 

The resulting sales function is then

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < R, \\ (1 - \alpha)q & \text{if } R \leq t < n, \\ f(t, N)(q + \delta) + [1 - f(t, N)](1 - \alpha)q & \text{if } n \leq t < N, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (2)$$

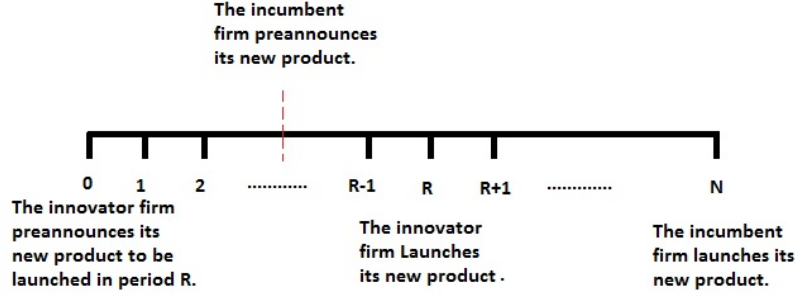
Preannouncement when innovator launches:  $n = R$ . For  $t < n$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  choose to wait for the innovator's product and the rest buy the incumbent's existing product. Those who choose to wait for the innovator can be converted when the incumbent preannounces, so there is a build-up of potential demand for the incumbent over the periods  $t = 1, \dots, n - 1$ . In the preannouncement period  $t = n$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  and of those who chose to wait for the innovator in periods  $t = 1, \dots, n - 1$  buy the incumbent's new product, the proportion  $1 - f(t, N)$  of those who chose to wait for the innovator in periods  $t = 1, \dots, n - 1$  and the proportion  $[1 - f(t, N)]\alpha$  of new customers buy the innovator's product, and the remaining proportion  $[1 - f(t, N)][1 - \alpha]$  of new customers buy the existing product of the incumbent. This assumes that if the customers who chose to wait for the innovator are not converted in the preannouncement period, they cannot be converted in the future. For  $n < t < N$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)]\alpha$  of new customers buy the innovator's product, and the rest buy the incumbent's existing product. Finally for  $t \geq N$ , the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product. Figure 4.3 shows the timetable for the duopoly case when the incumbent preannounces when the innovative launches.

Fig. 4.3: Timetable for the Duopoly Case When the Incumbent Preannounce at  $R$ 

The sales function in this case is

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < n, \\ f(t, N) \left[ 1 + \sum_{t'=1}^{t-1} g(t', R) \right] (q + \delta) + [1 - f(t, N)][1 - \alpha]q & \text{if } t = n, \\ f(t, N)(q + \delta) + [1 - f(t, N)](1 - \alpha)q & \text{if } n < t < N, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (3)$$

Preannouncement before innovator launches:  $1 \leq n < R$ . For  $t < n$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  choose to wait for the innovator's product and the rest buy the incumbent's existing product. In the preannouncement period  $t = n$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  and of those who chose to wait for the innovator in periods  $t = 1, \dots, n-1$  buy the incumbent's new product, the proportion  $1 - f(t, N)$  of those who chose to wait for the innovator in periods  $t = 1, \dots, n-1$  and the proportion  $[1 - f(t, N)]g(t, R)$  of new customers buy the innovator's product, and the remaining proportion  $[1 - f(t, N)][1 - g(t, R)]$  of new customers buy the existing product of the incumbent. For  $n < t < R$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)]g(t, R)$  of new customers buy the innovator's product, and the rest buy the incumbent's existing product. For  $R \leq t < N$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)]\alpha$  of new customers buy the innovator's product, and the rest buy the incumbent's existing product. Finally for  $t \geq N$ , the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product. Figure 4.4 shows the timetable for the duopoly case when the incumbent preannounces before the innovative launches.

Fig. 4.4: Timetable for the Duopoly Case When the Incumbent Preannounce before  $R$ 

The sales function in this case is

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < n, \\ f(t, N) \left[1 + \sum_{t'=1}^{t-1} g(t', R)\right] (q + \delta) + [1 - f(t, N)][1 - g(t, R)]q & \text{if } t = n, \\ f(t, N)(q + \delta) + [1 - f(t, N)][1 - g(t, R)]q & \text{if } n < t < R, \\ f(t, N)(q + \delta) + [1 - f(t, N)](1 - \alpha)q & \text{if } R \leq t < N, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (4)$$

We observe that the functions (1)-(4) have the same value for  $t \geq N$ ; therefore, to maximize the profit over all preannouncement strategies, the incumbent needs to consider only the profit from the sales that it generates over periods  $t = 1, \dots, N - 1$ . The  $(N - 1)$ -period profit  $U(n)$  of the incumbent firm if the new product is preannounced in period  $n$  is:

$$U(n) = \pi \sum_{t=1}^{N-1} S_t(n). \quad (5)$$

We restrict attention to the case where the conversion rates are:

$$g(t, R) = \frac{t\alpha}{R}, \quad (6)$$

$$f(t, N) = \frac{t\beta}{N}, \quad (7)$$

where  $0 < \alpha < 1$  and  $0 < \beta \leq 1$  are constant. Notice that  $g(t, R)$  and  $f(t, N)$  increase with  $t$  meaning that more customers are converted when there is less time to the launch. The following theorem characterizes the optimal preannouncement timing for the incumbent:

**Theorem 3:** In a duopolistic market, where the incumbent will launch a new product after  $N \geq 2$  periods from now and the innovator has preannounced its new product to be launched after  $1 \leq$

$R < N$  periods from now, an optimal preannouncement strategy of the incumbent is to preannounce immediately if

$$\frac{q}{\delta} \leq \frac{\frac{3R}{\alpha} + 3}{R + 1} - 3, \quad (8)$$

and to preannounce at the same time as the innovator launches its product, i.e. preannounce at  $t = R$ , if

$$\frac{q}{\delta} \geq \frac{\frac{3R}{\alpha} + 3}{R + 1} - 3. \quad (9)$$

In this theorem, there is a threshold for  $\frac{q}{\delta}$ .  $q$  represents the quality of the incumbent's existing product and  $\delta$  represents the quality difference between the incumbent's existing and the new products. If the new product is slightly better than the existing product (like an update of a software),  $\delta$  is small; if the new product is much better than the existing product (like regular cell phones and smart phones),  $\delta$  is big. The theorem indicates that if the proportion of the existing quality and the quality difference is greater than or equal to the right hand side, the incumbent should wait until the innovator launches; if this proportion is less than or equal to the right hand side, the firm should preannounce immediately.

**Proof.** First, we show that preannouncing strictly after the innovator launches its product is never optimal. For this, observe that for  $R < n \leq N - 1$ ,  $S_t(n + 1) = S_t(n)$  for  $1 \leq t \leq n - 1$  and  $t \geq n + 1$  by (1)-(2). This together with (5) gives:

$$U(n + 1) - U(n) = \pi[S_n(n + 1) - S_n(n)] = \pi f(t, N)[(1 - \alpha)q - (q + \delta)] < 0,$$

where the inequality follows from the positivity of  $\pi$ ,  $f(t, N)$ ,  $q$ ,  $\delta$  and the nonnegativity of  $\alpha$ . Hence  $U(N) < U(N - 1) < \dots < U(R + 2) < U(R + 1)$ . Also

$$\begin{aligned} U(R + 1) - U(R) &= \pi[S_R(R + 1) - S_R(R)] \\ &= \pi f(R, N) \left[ (1 - \alpha)q - \left[ 1 + \sum_{t'=1}^{t-1} g(t', R) \right] (q + \delta) \right] \\ &\leq \pi f(R, N)[(1 - \alpha)q - (q + \delta)] < 0. \end{aligned}$$

Hence  $n > R$  is never optimal. this means that an incumbent firm should never preannounce its new product after its rival launches a new product.

Now note that for  $1 \leq n < R$ ,  $S_t(n + 1) \neq S_t(n)$  only if  $t = n$  or  $t = n + 1$ . Consequently, the change in the incumbent's profit when it preannounces in period  $n + 1$  rather than  $n$  is

$$U(n + 1) - U(n) = \pi[S_n(n + 1) - S_n(n) + S_{n+1}(n + 1) - S_{n+1}(n)],$$

which reduces to

$$U(n + 1) - U(n) = \left( \frac{\pi n \alpha \beta \delta}{NR} \right) \left[ \frac{n + 1}{2} \left( \frac{q}{\delta} + 3 \right) - \left( \frac{R}{\alpha} + 1 \right) \right]$$

after rearranging the terms in (4). This expression equals zero if and only if  $n = \hat{n}$ , where

$$\hat{n} = \frac{2\left(\frac{R}{\alpha} + 1\right)}{\frac{q}{\delta} + 3} - 1.$$

If  $\hat{n} > R - 1$ , then  $U(n + 1) - U(n) < 0$  for all  $1 \leq n \leq R - 1$ , so that  $U(R) < \dots < U(1)$ . Else if  $\hat{n} < 1$ , then  $U(n + 1) - U(n) > 0$  for all  $1 \leq n \leq R - 1$ , so that  $U(R) > \dots > U(1)$ . Otherwise,  $1 \leq \hat{n} \leq R$  and there exists some integer  $m$  such that  $U(n + 1) - U(n) \leq 0$  for all  $1 \leq n \leq m - 1$  and  $U(n + 1) - U(n) \geq 0$  for all  $m \leq n \leq R - 1$ . Thus in any case either  $n = 1$  or  $n = R$  (or both) is an optimal preannouncement time. To see which, consider the difference

$$\begin{aligned} U(R) - U(1) &= \sum_{n=1}^{R-1} [U(n+1) - U(n)] \\ &= \sum_{n=1}^{R-1} \left( \frac{\pi n \alpha \beta \delta}{NR} \right) \left[ \frac{n+1}{2} \left( \frac{q}{\delta} + 3 \right) - \left( \frac{R}{\alpha} + 1 \right) \right] \\ &= \frac{\pi \alpha \beta \delta (R-1)}{2N} \left[ \frac{R+1}{3} \left( \frac{q}{\delta} + 3 \right) - \left( \frac{R}{\alpha} + 1 \right) \right]. \end{aligned}$$

Consequently,  $n = 1$  is optimal if the expression in brackets is nonpositive, and  $n = R$  is optimal if this expression is nonnegative.

$$\frac{R+1}{3} \left( \frac{q}{\delta} + 3 \right) - \left( \frac{R}{\alpha} + 1 \right) \leq \frac{q}{\delta} + 3 \leq \frac{\left(\frac{R}{\alpha} + 1\right) q}{\frac{R+1}{3} \delta} \leq \frac{\frac{3R}{\alpha} + 3}{R+1} - 3$$

This completes the proof of the theorem.  $\square$

The following is an immediate corollary of Theorem 3

Corollary 1: Given  $1 \leq R < N$ ,

- (i) For fixed  $0 < \alpha < 1$ , the incumbent firm should preannounce immediately if either the quality of the existing product is relatively low or the incremental quality of the new product is relatively high.
- (ii) For fixed ratio  $\frac{q}{\delta}$ , the incumbent firm should preannounce immediately if either  $\alpha$  is small or  $R$  is large.

**Proof.**

$$\frac{\partial \left( \frac{\frac{R}{\alpha} + 1}{R+1} - 1 \right)}{\partial R} = \frac{1 - \alpha}{\alpha(R+1)^2} \quad (10)$$

Even  $R$  is not continuous, taking the derivative gives the true intention. Since  $0 < \alpha < 1$  and square of an expression is always nonnegative, the right hand side is always positive meaning that as  $R$  increases, the right hand side of the inequality increases.

$$\frac{\partial \left( \frac{\frac{R}{\alpha} + 1}{R+1} - 1 \right)}{\partial \alpha} = -\frac{1}{\alpha^2} \quad (11)$$

Since square of an expression is always nonnegative, the right hand side is always negative meaning that as  $\alpha$  increases, the threshold decreases. This is the proof of Corollary 1 (ii).  $\square$

Theorem 3 and its corollary suggest that even though the new product is more profitable than the existing one for the incumbent firm, the firm can benefit from postponing the preannouncement in some cases. The presence of competition is the reason for this phenomenon, since preannouncing immediately is always optimal for a monopoly, as stated by Theorem 1. The intuition behind this is that before the preannouncement, the competitor keeps accumulating the demand for its future new product, but the incumbent firm can convert some of this demand to its own benefit. Customers who initially choose to wait for the innovative firm can change their minds when the incumbent firm preannounces its new product. Besides, for fixed  $\alpha$ , the incumbent firm should more likely preannounce the existing product that has relatively low quality or the new product relatively much better than the existing product. For fixed  $\frac{q}{\delta}$ , the incumbent firm should more likely preannounce if relatively more people wait for the innovator's new product or the innovator intends to launch its new product relatively closer to the date.

In order to derive the optimal preannouncement strategy for the innovative firm, let  $S'_t(n')$  denote the sales (in quality units,  $q'$ ) generated in period  $t$  if the firm preannounces in period  $1 \leq n' \leq R$ , where  $n' = R$  represents the case without preannouncement. For  $t \geq n'$ , the new product sales are included in  $S'_t(n')$  even though they are actualized when the product is launched in period  $R$ . Accordingly,

$$S'_t(n') = \begin{cases} 0 & \text{if } t < n', \\ g(t, R)q' & \text{if } n > t \geq n' g(t, R)(1 - f(t, N))q' \\ \text{if } n < t. \end{cases} \quad (12)$$

Since  $g(t, R) = \alpha$ , ( $0 \leq \alpha \leq 1$ ) for  $t \geq R$ , under any preannouncement strategy  $1 \leq n \leq R$ ,  $S'_t(n') = q'$  for  $t \geq R$ ; therefore to maximize its profit, the innovator needs to consider only the profit from the sales generated over periods  $t = 1, \dots, R - 1$ . The  $(R - 1)$ -period profit  $U'(n')$  of the firm if it preannounces in period  $n'$  is

$$U'(n') = \pi' \sum_{t=1}^{R-1} S'_t(n'). \quad (13)$$

The following theorem establishes the optimal preannouncement strategy for the innovative firm.

**Theorem 4:** The unique optimal preannouncement strategy of the innovative firm is to preannounce immediately.

**Proof.** For  $1 \leq n' \leq R-1$ ,  $S'_t(n'+1) = S'_t(n')$  for  $1 \leq t \leq n'-1$  and  $t \geq n'+1$  by (12). Using this and (13), the profit loss from deferring the preannouncement for one period can be expressed as

$$U'(n'+1) - U'(n') = \pi' \sum_{t=1}^{R-1} [S'_t(n'+1) - S'_t(n')] = \pi' [S'_{(n')}(n'+1) - S'_{(n')}(n')] = -\pi' g(n', R) < 0,$$

so  $U'(R) < U'(R-1) < \dots < U'(2) < U'(1)$  and preannouncing immediately is the unique optimal strategy.  $\square$

The innovative firm does not have a product on the market and its income is zero at the beginning. The firm can convert more people to its new product independent from the incumbent firm's preannouncement strategy by preannouncing as early as possible. This result indicates that a firm entering the market for the first time should preannounce its new product as soon as it knows when the new product will be ready to be launched.

## 4.2 Duopolistic Market Case with Discounting

This section introduces the same duopoly market as in Section 4.1 with discounting factor existence. In this case, the incumbent firm's income increases in value by  $\rho$  in time ( $0 \leq \rho < 1$ ). Only the existing product's income gets affected by this discounting factor since the new product brings money after it gets launched. As in Chapter 3, let  $S_t(n)$  be the sales (in quality units) that the incumbent generates in period  $t$  if it adopts the preannouncement strategy  $1 \leq n \leq N$ .

Not preannounce:  $n = N$ .

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < R, \\ (1 - \alpha)q & \text{if } R \leq t < n, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq n. \end{cases} \quad (14)$$

Preannounce after innovator launches:  $R < n < N$ .

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < R, \\ (1 - \alpha)q & \text{if } R \leq t < n, \\ f(t, N)(q + \delta)\rho^{N-t} + [1 - f(t, N)](1 - \alpha)q & \text{if } n \leq t < N, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (15)$$

Preannounce when innovator launches:  $n = R$ .

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < n, \\ f(t, N) \left[ 1 + \sum_{t'=1}^{t-1} g(t', R) \right] (q + \delta)\rho^{N-R} \\ + [1 - f(t, N)][1 - \alpha]q & \text{if } t = n, \\ f(t, N)(q + \delta)\rho^{N-t} + [1 - f(t, N)](1 - \alpha)q & \text{if } n < t < N, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (16)$$

Preannouncement before innovator launches:  $1 \leq n < R$ .

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < n, \\ f(t, N) \left[ 1 + \sum_{t'=1}^{t-1} g(t', R) \right] (q + \delta) \rho^{N-t} & \\ + [1 - f(t, N)][1 - g(t, R)]q & \text{if } t = n, \\ f(t, N)(q + \delta) \rho^{N-t} + [1 - f(t, N)][1 - g(t, R)]q & \text{if } n < t < R, \\ f(t, N)(q + \delta) \rho^{N-t} + [1 - f(t, N)](1 - \alpha)q & \text{if } R \leq t < N, \\ (1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (17)$$

We observe that the functions (14)-(17) have the same value for  $t \geq N$ ; therefore, to maximize the profit over all preannouncement strategies, the incumbent needs to consider only the profit from the sales that it generates over periods  $t = 1, \dots, N - 1$ . The  $(N - 1)$ -period profit  $U(n)$  of the incumbent firm if the new product is preannounced in period  $n$  is:

$$U(n) = \pi \sum_{t=1}^{N-1} \rho^t S_t(n). \quad (18)$$

We restrict attention to the case where the conversion rates are:

$$g(t, R) = \frac{t\alpha}{R}, \quad (19)$$

$$f(t, N) = \frac{t\beta}{N}, \quad (20)$$

where  $0 < \alpha < 1$  and  $0 < \beta \leq 1$  are constant.

The change in the incumbent's profit when it preannounces in period  $n + 1$  rather than  $n$  is

$$U(n + 1) - U(n) = \pi \left[ \sum_{t=1}^{N-1} \rho^t (S_t(n + 1) - S_t(n)) \right],$$

which reduces to

$$U(n + 1) - U(n) = \left( \frac{\pi n \beta \delta}{N} \right) \left[ \frac{q}{\delta} (1 - \alpha - \rho^{N-n}) - \rho^{N-n} \right]$$

after rearranging the terms. This expression is non-positive if the inside of the bracket is non-positive.

So9, this expression is non-positive if  $\frac{q}{\delta}(1 - \alpha - \rho^{N-n}) - \rho^{N-n}$ . Followingly,

$$\frac{q}{\delta} \leq \sum_{n=1}^{N-1} \frac{\rho^{N-n}}{1 - \alpha - \rho^{N-n}}$$

In case the threshold is greater than the right hand side, the incumbent firm should not preannounce the new products at all. However, if the threshold is less than the right hand side, it means the firm

should preannounce the product and the steps below should be followed to find out the optimal preannouncing time.

$$U(n+1) - U(n) = \left( \frac{\pi n \alpha \beta \delta \rho^{N-n}}{NR} \right) \left[ \frac{q}{\delta} \left( \frac{(n+1)^2}{2\rho} - \frac{n^2-1}{2} + \frac{R-n\alpha}{\alpha \rho^{N-n}} \right) - \left( \frac{(n+1)^2}{2\rho} - \frac{n^2-1}{2} \right) \right]$$

after rearranging the terms.

Since this expression is mathematically difficult to analyze, we run a numerical analysis to compare the case with a discounting factor and without one. Table 4.1 compares the threshold for  $\frac{q}{\delta}$  with different  $R$  (3, 4 and 5),  $\alpha$  (0.2, 0.5 and 0.8), and  $\rho$  (0.2, 0.5 and 0.8) values when  $N=6$ . We have chosen  $N$  as 6 because this number is big enough to give different values to  $R$  and small enough for simplification.

Tab. 4.1: Comparison of the threshold with and without  $\rho$

| $R$ | $\alpha$ | $\rho$ | Threshold with $\rho$ | Threshold without $\rho$ |
|-----|----------|--------|-----------------------|--------------------------|
| 3   | 0.2      | 0.2    | 0.0006                | 9                        |
| 3   | 0.2      | 0.5    | 0.017                 | 9                        |
| 3   | 0.2      | 0.8    | 0.082                 | 9                        |
| 3   | 0.5      | 0.2    | 0.0017                | 2.25                     |
| 3   | 0.5      | 0.5    | 0.049                 | 2.25                     |
| 3   | 0.5      | 0.8    | 0.21                  | 2.25                     |
| 3   | 0.8      | 0.2    | 0.003                 | 0.56                     |
| 3   | 0.8      | 0.5    | 0.09                  | 0.56                     |
| 3   | 0.8      | 0.8    | 0.34                  | 0.56                     |
| 4   | 0.2      | 0.2    | 0.0009                | 9.6                      |
| 4   | 0.2      | 0.5    | 0.022                 | 9.6                      |
| 4   | 0.2      | 0.8    | 0.09                  | 9.6                      |
| 4   | 0.5      | 0.2    | 0.003                 | 2.4                      |
| 4   | 0.5      | 0.5    | 0.06                  | 2.4                      |
| 4   | 0.5      | 0.8    | 0.22                  | 2.4                      |
| 4   | 0.8      | 0.2    | 0.005                 | 0.6                      |
| 4   | 0.8      | 0.5    | 0.11                  | 0.6                      |
| 4   | 0.8      | 0.8    | 0.35                  | 0.6                      |
| 5   | 0.2      | 0.2    | 0.0013                | 10                       |
| 5   | 0.2      | 0.5    | 0.029                 | 10                       |
| 5   | 0.2      | 0.8    | 0.092                 | 10                       |
| 5   | 0.5      | 0.2    | 0.0036                | 2.5                      |
| 5   | 0.5      | 0.5    | 0.076                 | 2.5                      |
| 5   | 0.5      | 0.8    | 0.23                  | 2.5                      |
| 5   | 0.8      | 0.2    | 0.006                 | 0.625                    |
| 5   | 0.8      | 0.5    | 0.13                  | 0.625                    |
| 5   | 0.8      | 0.8    | 0.36                  | 0.625                    |

The numerical analysis indicates that  $U(R) - U(1)$  expression without the discounting factor is always greater than  $U(R) - U(1)$  expression with the discounting factor. This means that the discounting factor takes the threshold backward.  $\frac{q}{\delta}$  is more likely to be greater than the threshold with the existence of discounting factor. In this case, the incumbent firm postpones the preannouncement

to the innovator's launch. This result is consistent with the idea that the incumbent increases the profit from the existing product since the income from the existing product brings more profit relative to the future income that will be generated from the new product when there is a discounting factor.

## 5. PREANNOUNCEMENT IN A DUOPOLISTIC MARKET WITH AN UNRELIABLE INNOVATOR

This section focuses on the case that the innovative firm may not launch its new product with a probability  $p$ . As in Chapter 3, the incumbent firm has an existing product in the market and is currently working on a new product that will be launched after  $N \geq 2$  periods from now. The innovative firm does not have any product in the market at present; however, it has just preannounced the new product with which it will enter the market after  $1 \leq R < N$  periods from now. This section differs from Section 4.1 in that the innovative firm will not be able to launch its new product with a probability  $p$ . Players do not know whether the innovative firm will be successful or not until period  $R$ . So,  $g(t, R)$  proportion of the customers will continue to postpone their purchases for the innovative firm's new product until the period  $R$ . If the innovative firm cannot launch this product, those postponing customers will have two options: To buy the incumbent firm's existing product or to wait for the incumbent firm's new product in case it is preannounced. The incumbent firm's total profit will be the same with Section 4.1 with the probability of  $(1 - p)$  and it will increase by the customers coming back from the innovative firm with the probability of  $p$ . The question for the incumbent firm is again whether to preannounce its new product in any period or not.

The market demand follows the same pattern as the setting in Section 4.1, i.e., one customer joins the market in every period and it is shared between the incumbent and the innovator; however, now the innovative firm may not launch its new product. The division of demand between the two firms is based on the assumption that conversion to a new product occurs only when customers are exposed to new information. The exposition of a customer to new information in a period can be in three ways: either the customer joins the market in that period or the incumbent firm preannounces its new product in that period or the innovative firm cannot launch its new product in that period. Consequently, the main difference from the duopolistic market is that the customers who wait for the innovative firm's product can buy the incumbent firm's existing product or wait for the incumbent firm's new product in case the innovative firm cannot launch its new product.

Let  $n \in \{1, \dots, N\}$  denote the period in which the incumbent preannounces,  $0 < f(t, N) \leq 1$  for  $t < N$  and  $0 \leq g(t, R) \leq 1$  for  $t < R$  be the conversion rates of the incumbent and the innovator, respectively. We assume that once the innovator launches its product (if it manage to launch it), its market share stabilizes at rate  $0 \leq \alpha \leq 1$  and once the incumbent launches its new product, it does

not produce the existing product and the market share of its new product stabilizes at rate  $1 - \alpha$ . Preannouncement strategies available to the incumbent and resulting demand are detailed below. As in Chapter 3, let  $S_t(n)$  be the sales (in quality units) that the incumbent generates in period  $t$  if it adopts the preannouncement strategy  $1 \leq n \leq N$ .

Not preannounce:  $n = N$ . For  $t < R$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product. For  $t = R$ , the customers who join the market in period  $t$  and the customers who choose to buy the innovator's product buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . For  $R < t < n = N$ , all the customers who join the market in period  $t$  buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . For  $t \geq n = N$ , all the customers who join the market in period  $t$  buy the incumbent's new product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product in case the innovator launches with probability  $(1 - p)$ . Accordingly,

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < R, \\ p(1 + \sum_{t'=1}^{R-1} g(t', R))q + (1 - p)(1 - \alpha)q & \text{if } t = R, \\ pq + (1 - p)(1 - \alpha)q & \text{if } R < t < n, \\ p(q + \delta) + (1 - p)(1 - \alpha)(q + \delta) & \text{if } t \geq n. \end{cases} \quad (1)$$

Preannounce after innovator launches:  $R < n < N$ . In this case, the customers who prefer the innovator cannot be converted, since the innovator's product is already in the market when the incumbent preannounces. For  $t < R$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product. For,  $t = R$ , the customers who join the market in period  $t$  and the customers who choose to buy the innovator's product buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . For  $R < t < n$ , all the customers who join the market in period  $t$  buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . For  $n \leq t < N$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product and the rest buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $f(t, N)$  of customers

who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)]\alpha$  of customers who join the market in period  $t$  buy the innovator's product, and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . For  $t \geq N$ , all the customers who join the market in period  $t$  buy the incumbent's new product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product in case the innovator launches with probability  $(1 - p)$ . The resulting sales function is then

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < R, \\ p(1 + \sum_{t'=1}^{R-1} g(t', R))q + (1 - p)(1 - \alpha)q & \text{if } t = R, \\ pq + (1 - p)(1 - \alpha)q & \text{if } R < t < n, \\ \begin{cases} p(f(t, N)(q + \delta) + [1 - f(t, N)]q) \\ +(1 - p)(f(t, N)(q + \delta) + [1 - f(t, N)](1 - \alpha)q) \end{cases} & \text{if } n \leq t < N, \\ p(q + \delta) + (1 - p)(1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (2)$$

Preannounce when innovator launches:  $n = R$ . For  $t < n$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  choose to buy the innovator's product and the rest buy the incumbent's existing product. Those who choose to wait for the innovator can be converted when the incumbent preannounces, so there is a build-up of potential demand for the incumbent over the periods  $t = 1, \dots, n - 1$ . In the preannouncement period  $t = n$ , the proportion  $f(t, N)$  of the customers who join the market in period  $t$  and the customers who choose to wait for the innovator's product buy the incumbent's new product and the rest buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $f(t, N)$  of customers who join the market in period  $t$  and of those who chose to wait for the innovator in periods  $t = 1, \dots, n - 1$  buy the incumbent's new product, the proportion  $1 - f(t, N)$  of those who chose to wait for the innovator in periods  $t = 1, \dots, n - 1$  and the proportion  $[1 - f(t, N)]\alpha$  of new customers buy the innovator's product, and the remaining proportion  $[1 - f(t, N)][1 - \alpha]$  of new customers buy the existing product of the incumbent in case the innovator launches with probability  $(1 - p)$ . This assumes that if the customers who chose to wait for the innovator are not converted in the preannouncement period, they cannot be converted in the future. For  $n < t < N$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product and the rest buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)]\alpha$  of new customers buy the innovator's product, and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . Finally for  $t \geq N$ , all the customers who join the market in period  $t$  buy the incumbent's new product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product in case the innovator launches with probability  $(1 - p)$ . The sales function in this case is

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < n, \\ p[(1 + \sum_{t'=1}^{R-1} g(t', R))f(t, N)(q + \delta) \\ + (1 + \sum_{t'=1}^{R-1} g(t', R))(1 - f(t, N))q] \\ + (1 - p)[(1 + \sum_{t'=1}^{R-1} g(t', R))f(t, N)(q + \delta) \\ + (1 - f(t, N))(1 - \alpha)q] & \text{if } t = n, \\ p[f(t, N)(q + \delta) + (1 - f(t, N))q] \\ + (1 - p)[f(t, N)(q + \delta) + (1 - f(t, N))(1 - \alpha)q] & \text{if } n < t < N, \\ p(q + \delta) + (1 - p)(1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (3)$$

Preannounce before innovator launches:  $1 \leq n < R$ . For  $t < n$ , the proportion  $g(t, R)$  of customers who join the market in period  $t$  choose to wait for the innovator's product and the rest buy the incumbent's existing product. Those who choose to wait for the innovator can be converted when the incumbent preannounces, so there is a build-up of potential demand for the incumbent over the periods  $t = 1, \dots, n - 1$ . In the preannouncement period  $t = n$ , the proportion  $f(t, N)$  of the customers who join the market in period  $t$  and the customers who choose to wait for the innovator's product wait for the incumbent's new product and the rest buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $f(t, N)$  of customers who join the market in period  $t$  and of those who chose to wait for the innovator in periods  $t = 1, \dots, n - 1$  buy the incumbent's new product, the proportion  $1 - f(t, N)$  of those who chose to wait for the innovator in periods  $t = 1, \dots, n - 1$  and the proportion  $[1 - f(t, N)]\alpha$  of new customers buy the innovator's product, and the remaining proportion  $[1 - f(t, N)][1 - \alpha]$  of new customers buy the existing product of the incumbent in case the innovator launches with probability  $(1 - p)$ . This assumes that if the customers who chose to wait for the innovator are not converted in the preannouncement period, they cannot be converted in the future. For  $n < t < R$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product and the rest buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)][1 - g(t, R)]$  of new customers buy the innovator's product, and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . For  $R \leq t < N$ , the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product and the rest buy the incumbent's existing product in case the innovator cannot launch with probability  $p$ ; the proportion  $f(t, N)$  of customers who join the market in period  $t$  buy the incumbent's new product, the proportion  $[1 - f(t, N)]\alpha$  of new customers buy the innovator's product, and the rest buy the incumbent's existing product in case the innovator launches with probability  $(1 - p)$ . Finally for  $t \geq N$ , all the customers who join the market in period  $t$  buy the incumbent's new product in case the innovator cannot launch with probability  $p$ ; the proportion  $\alpha$  of customers who join the market in period  $t$  buy the innovator's product and the rest buy the incumbent's new product in case the innovator launches with probability  $(1 - p)$ . The sales function in this case is

$$S_t(n) = \begin{cases} [1 - g(t, R)]q & \text{if } t < n, \\ \begin{aligned} & p[(1 + \sum_{t'=1}^{R-1} g(t', R))f(t, N)(q + \delta) \\ & + (1 + \sum_{t'=1}^{R-1} g(t', R))(1 - f(t, N))q] \\ & + (1 - p)[(1 + \sum_{t'=1}^{R-1} g(t', R))f(t, N)(q + \delta) \\ & + (1 - f(t, N))(1 - g(t, R))q] \end{aligned} & \text{if } t = n, \\ \begin{aligned} & p[f(t, N)(q + \delta) + (1 - f(t, N))q] \\ & + (1 - p)[f(t, N)(q + \delta) + (1 - f(t, N))(1 - g(t, R))q] \end{aligned} & \text{if } n < t < R, \\ \begin{aligned} & p[f(t, N)(q + \delta) + (1 - f(t, N))q] \\ & + (1 - p)[f(t, N)(q + \delta) + (1 - f(t, N))(1 - \alpha)q] \end{aligned} & \text{if } R \leq t < N, \\ p(q + \delta) + (1 - p)(1 - \alpha)(q + \delta) & \text{if } t \geq N. \end{cases} \quad (4)$$

We observe that the functions (1)-(4) have the same value for  $t \geq N$ ; therefore, to maximize the expected profit over all preannouncement strategies, the incumbent needs to consider only the profit from the sales that it generates over periods  $t = 1, \dots, N - 1$ . The  $(N - 1)$ -period expected profit  $U(n)$  of the incumbent firm if the new product is preannounced in period  $n$  is:

$$U(n) = \pi \sum_{t=1}^{N-1} S_t(n). \quad (5)$$

We restrict attention to the case where the conversion rates are:

$$g(t, R) = \frac{t\alpha}{R}, \quad (6)$$

$$f(t, N) = \frac{t\beta}{N}, \quad (7)$$

where  $0 < \alpha < 1$  and  $0 < \beta \leq 1$  are constant.

**Theorem 5:** In a duopolistic market with an unreliable innovator, where the incumbent will launch a new product after  $N \geq 2$  periods from now and the innovator has preannounced its new product to be launched after  $1 \leq R < N$  periods from now but may not launch with a probability  $p$ , an optimal preannouncement strategy of the incumbent is to preannounce immediately if

$$\frac{q}{\delta} \leq \frac{3\left(\frac{R}{\alpha} - R\right)}{(1-p)(R+1)}, \quad (8)$$

and to preannounce at the same time as the innovator launches its product, i.e. preannounce at  $t = R$ , if

$$\frac{q}{\delta} \geq \frac{3\left(\frac{R}{\alpha} - R\right)}{(1-p)(R+1)}. \quad (9)$$

**Proof.** First, we show that preannouncing strictly after the innovator launches its product is never optimal. For this, observe that for  $R < n \leq N - 1$ ,  $S_t(n+1) = S_t(n)$  for  $1 \leq t \leq n - 1$  and  $t \geq n + 1$  by (1)-(2). This together with (5) gives:

$$U(n+1) - U(n) = \pi[S_n(n+1) - S_n(n)] < 0,$$

where the inequality follows from the positivity of  $\pi, f(t, N), q, \delta$  and the nonnegativity of  $\alpha$  and  $p$ . Hence  $U(N) < U(N-1) < \dots < U(R+2) < U(R+1)$ . Also

$$\begin{aligned}
U(R+1) - U(R) &= \pi[S_R(R+1) - S_R(R)] \\
&= \pi[p(1 + \sum_t^{R+1} g(t, R))q + (1-p)(1-\alpha)q \\
&\quad - p[(1 + \sum_t^{R+1} g(t, R))f(t, N)(q + \delta) + (1 + \sum_t^{R+1} g(t, R))(1 - f(t, N))q] \quad (10) \\
&\quad - (1-p)[f(t, N)(1 + \sum_t^{R+1} g(t, R))(q + \delta) + (1 - f(t, N))(1 - \alpha)q] < 0. \quad (11)
\end{aligned}$$

Hence  $n > R$  is never optimal.

Now note that for  $1 \leq n < R$ ,  $S_t(n+1) \neq S_t(n)$  only if  $t = n$  or  $t = n+1$ . Consequently, the change in the incumbent's profit when it preannounces in period  $n+1$  rather than  $n$  is

$$U(n+1) - U(n) = \pi[S_n(n+1) - S_n(n) + S_{n+1}(n+1) - S_{n+1}(n)],$$

which reduces to

$$U(n+1) - U(n) = \left( \frac{\pi n \alpha \beta \delta}{2NR} \right) \left[ (n+1) \left( \frac{q}{\delta} - \frac{pq}{\delta} + 3 \right) - 2 \left( \frac{R}{\alpha} + 1 \right) \right]$$

This expression equals zero if and only if  $n = \hat{n}$ , where

$$\hat{n} = \frac{2 \left( \frac{R}{\alpha} + 1 \right)}{\frac{q}{\delta} (1-p) + 3} - 1.$$

If  $\hat{n} > R-1$ , then  $U(n+1) - U(n) < 0$  for all  $1 \leq n \leq R-1$ , so that  $U(R) < \dots < U(1)$ . Else if  $\hat{n} < 1$ , then  $U(n+1) - U(n) > 0$  for all  $1 \leq n \leq R-1$ , so that  $U(R) > \dots > U(1)$ . Otherwise,  $1 \leq \hat{n} \leq R$  and there exists some integer  $m$  such that  $U(n+1) - U(n) \leq 0$  for all  $1 \leq n \leq m-1$  and  $U(n+1) - U(n) \geq 0$  for all  $m \leq n \leq R-1$ . Thus in any case either  $n=1$  or  $n=R$  (or both) is an optimal preannouncement time. To see which, consider the difference

$$\begin{aligned}
U(R) - U(1) &= \sum_{n=1}^{R-1} [U(n+1) - U(n)] \\
&= \sum_{n=1}^{R-1} \left( \frac{\pi n \alpha \beta \delta}{2NR} \right) \left[ (n+1) \left( \frac{q}{\delta} - \frac{pq}{\delta} + 3 \right) - 2 \left( \frac{R}{\alpha} + 1 \right) \right] \\
&= \frac{\pi \alpha \beta \delta (R-1)}{2N} \left[ \frac{R+1}{3} \left( \frac{q}{\delta} (1-p) \right) - \left( \frac{R}{\alpha} - R \right) \right].
\end{aligned}$$

Consequently,  $n=1$  is optimal if the expression in brackets is nonpositive, and  $n=R$  is optimal if this expression is nonnegative. This completes the proof of the theorem.  $\square$

Corollary 1 is valid for Theorem 5. Besides, the following is an immediate corollary of Theorem 5

Corollary 2: Given  $1 \leq R < N$ ,

- (i) For fixed  $0 < \alpha < 1$ , the incumbent firm should preannounce immediately if the innovative firm is unreliable comparing with the innovative firm is completely reliable.
- (ii) For fixed ratio  $\frac{q}{\delta}$ , the incumbent firm should preannounce immediately if  $p$  is large.

**Proof.** The threshold in Section 4.1 is always smaller than the threshold in Section 5 since  $0 \leq p \leq 1$ . This is the proof of Corollary 2 (i).

$$\frac{\partial \left( \frac{\frac{R}{\alpha} - R}{(1-p)(R+1)} \right)}{\partial p} = \frac{\frac{R}{\alpha} - R}{(1-p)^2(R+1)} \quad (12)$$

Since  $0 < \alpha < 1$  and square of an expression is always nonnegative, the right hand side is always positive meaning that as  $p$  increases, the threshold increases. This is the proof of Corollary 2 (ii).

□

Theorem 5 and its corollary suggest that when the incumbent firm knows that the innovative firm may not launch its new product, the incumbent firm tends to preannounce immediately. In this case, the market is closer to monopoly for the incumbent firm since the incumbent firm is the only firm in the market in case the innovative firm cannot launch. Preannouncing immediately is always optimal for a monopoly, as stated by Theorem 1. So, the presence of the probability of the innovative firm not launching takes the right hand side of the threshold forward. This means that the incumbent firm will more likely preannounce immediately. This result is based on that less number of customers prefer to buy the incumbent's existing product instead of waiting for its new product in case the innovator cannot launch its new product when the incumbent preannounces in the first stage.

We run a numerical analysis to compare the case with a reliability and without it. Table 5.1 compares the threshold for  $\frac{q}{\delta}$  with different  $R$  (3, 4 and 5),  $\alpha$  (0.2, 0.5 and 0.8), and  $p$  (0.2, 0.5 and 0.8) when  $N = 6$ .

The numerical analysis indicates that the threshold always increases with the existence of unreliability of the innovative firm. This means that unreliability takes the threshold forward.  $\frac{q}{\delta}$  is more likely to be greater than the threshold when the innovator is completely reliable. The incumbent firm tends to preannounce later in this case. This results from the numerical analysis confirms the results from the analytical model.

Tab. 5.1: Comparison of the threshold with and without unreliability

| $R$ | $\alpha$ | $p$ | Threshold with $p$ | Threshold without $p$ |
|-----|----------|-----|--------------------|-----------------------|
| 3   | 0.2      | 0.2 | 11.25              | 9                     |
| 3   | 0.2      | 0.5 | 18                 | 9                     |
| 3   | 0.2      | 0.8 | 45                 | 9                     |
| 3   | 0.5      | 0.2 | 2.8125             | 2.25                  |
| 3   | 0.5      | 0.5 | 4.5                | 2.25                  |
| 3   | 0.5      | 0.8 | 11.25              | 2.25                  |
| 3   | 0.8      | 0.2 | 0.7                | 0.56                  |
| 3   | 0.8      | 0.5 | 1.125              | 0.56                  |
| 3   | 0.8      | 0.8 | 2.8125             | 0.56                  |
| 4   | 0.2      | 0.2 | 12                 | 9.6                   |
| 4   | 0.2      | 0.5 | 19.2               | 9.6                   |
| 4   | 0.2      | 0.8 | 48                 | 9.6                   |
| 4   | 0.5      | 0.2 | 3                  | 2.4                   |
| 4   | 0.5      | 0.5 | 4.8                | 2.4                   |
| 4   | 0.5      | 0.8 | 12                 | 2.4                   |
| 4   | 0.8      | 0.2 | 0.75               | 0.6                   |
| 4   | 0.8      | 0.5 | 1.2                | 0.6                   |
| 4   | 0.8      | 0.8 | 3                  | 0.6                   |
| 5   | 0.2      | 0.2 | 12.5               | 10                    |
| 5   | 0.2      | 0.5 | 20                 | 10                    |
| 5   | 0.2      | 0.8 | 50                 | 10                    |
| 5   | 0.5      | 0.2 | 3.125              | 2.5                   |
| 5   | 0.5      | 0.5 | 5                  | 2.5                   |
| 5   | 0.5      | 0.8 | 12.5               | 2.5                   |
| 5   | 0.8      | 0.2 | 0.78               | 0.625                 |
| 5   | 0.8      | 0.5 | 1.25               | 0.625                 |
| 5   | 0.8      | 0.8 | 3.125              | 0.625                 |

## 6. EXPERIMENTAL STUDIES

Apart from the analytical model, we designed an experimental environment to see how people react to preannouncement. These experiments do not test the all analytical results and do not cover all the assumptions of the analytical models but are related to the results of them. One of the main findings of the analytical models is that an incumbent firm should never preannounce its new product after the innovative firm launches its product. So, we predict that early preannouncement (preannouncement before the innovator launches) makes fewer less people to wait for the incumbent's new product. Another point of the experiment comes from the threshold ( $\frac{q}{s}$ ) we used in duopoly markets. Corollary 1 (*i*) indicates that the incumbent firm should more likely preannounce immediately if the incremental quality of the new product is relatively high. So, we predict that the subjects will more likely prefer to postpone their purchase decisions when the quality difference between the incumbent's current and new products is higher. Based on these predictions, hypotheses are:

*H1: The later the incumbent preannounces, the more likely the customers buy the incumbent's existing product.*

*H2: The lower the quality difference between the incumbent's existing and new products, the more likely the customers buy the incumbent's existing product.*

In this experiment, preannouncement time and quality difference are independent variables while the number of purchases of the products are the dependent variables. The experiment we designed and its results are presented below.

### 6.1 Method

We presented the following story to 110 Koç University undergraduate marketing students and they gained class credit for participating this experiment.

*You are starting a new academic year at Koç University, it is October 1st. As a Koç University student, you need to use statistical analysis software for your studies and research. You will be using this type of software in many of your classes, not only this year but also next year. You wont have any tutorials on how to use this type of software but statistical analysis software typically has very user-friendly manuals. Assume that you own a laptop but that you do not have this kind of software on it. You can access the statistical analysis software called STATA 2009 using the common computers on campus. STATA 2009 is the version that was introduced 6 years ago by STATA Company. One*

problem with using the software on the common computers is that in busy weeks it can be difficult to find an available common computer and you may waste time waiting. You have the alternative to buy a legal personal copy of statistical analysis software online for your own laptop.

STATA Company has been consistently launching updated versions of this software every 3 years since 1997. The current version on the market is STATA 2012 and it was introduced 3 years ago. STATA Company offers student price for STATA 2012 which is 49 TL. While both the 2009 and the 2012 versions have the functionality to complete your assignments and projects, STATA 2012 is slightly faster, includes a few additional analysis options, and it has slightly better graphics.

In what follows, we ask you what you plan to do (e.g. purchase a software package, not purchase) given the situation just described. You have to decide stage by stage what to do. The first stage will be October 1st 2014, and then follow a number of other stages which are 15 days apart (October 1st, October 15th, etc). The last stage will be December 1st. Keep in mind that your budget allows you to purchase at most one product in case you want to buy one.

This is a multi-stage purchase decision experiment. We asked the subjects to decide on whether to purchase one of the products on the market or not to purchase any product at each of 5 consecutive stages. There are 15 days between stages and the subjects saw the day they decided on. We chose to give 15 days between the stages because we could cover half a semester this way. Since we predicted that there would be significant purchase differences between early-late preannouncements and low-high quality differences, we manipulated quality difference between the existing product and the new product and preannouncement timing. For this purpose, 2 of 4 experimental groups were assigned to low quality difference manipulation while the other 2 groups were assigned to high quality difference manipulation. Likewise, 2 of 4 experimental groups were assigned to early preannouncement manipulation while the other 2 groups were assigned to late preannouncement manipulation. How we presented these manipulations are stated below. Eventually, all participants were randomly assigned to one of four (2x2) conditions: early preannouncement-low quality difference, early preannouncement-high quality difference, late preannouncement-low quality difference, and late preannouncement-high quality difference. The numbers of participants of each condition are shown in Table 6.1.

Tab. 6.1: The Numbers of Participants of Each Conditions

|                         | Early Preannouncement | Late Preannouncement |
|-------------------------|-----------------------|----------------------|
| Low Quality Difference  | 27                    | 28                   |
| High Quality Difference | 28                    | 27                   |

There are an incumbent firm (the firm with an existing product on the market) and an innovative firm (the newcomer firm) in the experiment. The experiment starts with the innovative firms preannouncement at the first stage stating that its new product will be launched at stage 3. Dif-

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ferently from the analytical model, all the participants enter the market in the first stage and the customers may not buy a product at all. The participants in early preannouncement condition saw the incumbent firms preannouncement at stage 2 stating that the new product would be launched at stage 5 while the participants in late preannouncement condition got this information at stage 4. All participants could purchase the innovative firms product at stage 3 and the incumbent firms new product at stage 5 for the first time since these are the launching periods of these products. However, once a participant purchased a product, she was directed to the questionnaire part meaning that all the participant didn't got all the information in case they bought a product before stage 5. The participants in low quality difference condition saw that there was a low quality difference between the incumbent firms existing product and its new product in the incumbent firms preannouncement stage (stage 2 or stage 4, accordingly). We said the new product would be slightly faster, it would include a few more additional analysis options, and it would offer slightly better graphics than the existing product to this group. The participants in high quality difference condition saw that there was a high quality difference between the incumbent firms existing product and its new product in the incumbent firms preannouncement stage (stage 2 or stage 4, accordingly). We said the new product would be much faster, it would include many more additional analysis options, and it would offer much better graphics than the existing product to this group. A questionnaire followed those stages including questions that the participants' thoughts about the quality difference between the incumbent firms existing product and its new product (We used 7 point-Likert Scale to measure the preferences: 1 is very slight improvement, 7 is very big improvement) to see whether the quality difference manipulation worked. The next questions were the quality difference between the innovative firms product and the incumbent firms existing product (We used 7 point-Likert Scale to measure the preferences: 1 is slightly better than the incumbents existing product, 7 is much better than the incumbents existing product) to see whether the participants understood the quality of the innovative firm's product; whether the innovative firm would launch the product on time or not to see the story had an impression that the innovative firm was not reliable. Lastly, we asked questions that experience with statistical tools, academic standing, being an exchange student or not, gender and age to see whether these factors have effects on the decisions. In sum, the subjects saw the story firstly. Then, they saw the innovator's preannouncement in stage 1. The ones in early preannouncement condition saw the incumbent's preannouncement and the ones in late preannouncement condition saw nothing in stage 2. They saw the innovator's launching in stage 3. The ones in late preannouncement condition saw the incumbent's preannouncement and the ones in early preannouncement condition saw nothing in stage 4. They saw the incumbent's launching stage 5. Finally, they saw the questionnaire. The whole experiment can be seen in the appendix.

## 6.2 Results and Discussion

In the light of the results of analytical model from Section 4, we predicted that there would be a significant difference between early and late preannouncement conditions and the subjects would more likely prefer to postpone their purchase decisions in the early preannouncement condition. Other than that, we predicted that there would be a significant difference between low and high quality difference conditions and the subjects would more likely prefer to postpone their purchase decisions in the high quality difference condition. However, the experimental results do not support these predictions. Still, we have some notable results. The numbers of purchases for each product in each condition are shown in Table 6.2.

Tab. 6.2: Experimental Results: The Numbers of Purchases of Each Product

| Purchased Product                       | Early Preannouncement  | Early Pre. | Late Pre. | Late Pre. |
|-----------------------------------------|------------------------|------------|-----------|-----------|
|                                         | Low Quality Difference | High QD    | Low QD    | High QD   |
| STATA 12 (Incumbent's existing product) | 14                     | 21         | 16        | 18        |
| STATA 15 (Incumbent's new product)      | 4                      | 1          | 5         | 1         |
| SAP (Innovative's product)              | 4                      | 5          | 5         | 2         |
| None                                    | 5                      | 1          | 2         | 6         |
| Total                                   | 27                     | 28         | 28        | 27        |

The subjects answered the question How much improvement do you think STATA has offered between STATA 2012 and STATA 2015 and were asked to choose a number between 1 and 7 (1 is very slight improvement, 7 is very big improvement). This question was asked to check whether the quality difference manipulation worked and we saw it did not work properly. The average in low quality difference was supposed to be lower than the average in high quality difference. However, the average in low quality difference is 4.12, while the average in high quality difference is 3.61.

We used parametric z-test to analyze the product purchases. In this method, we divided all the customers as product buyer and product non-buyer for each manipulation group. The results and test are presented below for STATA 12 and STATA 15.

Tab. 6.3: Experimental Results for STATA 12 and STATA 15

|         | STATA 12 buyer | STATA 12 non-buyer | STATA 15 buyer | STATA 15 non-buyer | Total |
|---------|----------------|--------------------|----------------|--------------------|-------|
| Low QD  | 30             | 25                 | 9              | 46                 | 55    |
| High QD | 39             | 16                 | 3              | 52                 | 55    |
| Total   | 69             | 41                 | 12             | 98                 | 110   |

z-test for STATA 15:

$\pi_1$ : Number of purchases of STATA 15 in low quality difference group

$\pi_2$ : Number of purchases of STATA 15 in high quality difference group

$$H_0 : \pi_1 = \pi_2, H_1 : \pi_1 \neq \pi_2$$

$$p_1 = \frac{9}{55} \quad p_2 = \frac{3}{55} \quad p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2} = \frac{12}{110} \quad s = \sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} = 0.06 \quad z = \frac{p_1 - p_2}{s} = 1.81$$

Since  $1.81 > 1.64$  (1.64 is critical value at significance level 0.1), we reject  $H_0$ .

z-test for STATA 12:

$\pi_1$ : Number of purchases of STATA 12 in low quality difference group

$\pi_2$ : Number of purchases of STATA 12 in high quality difference group

$$H_0 : \pi_1 = \pi_2, H_1 : \pi_1 \neq \pi_2$$

$$p_1 = \frac{30}{55} \quad p_2 = \frac{39}{55} \quad p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2} = \frac{69}{110} \quad s = \sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} = 0.092 \quad z = \frac{p_1 - p_2}{s} = 1.78$$

Since  $1.78 > 1.64$  (1.64 is critical value at significance level 0.1), we reject  $H_0$ .

The subjects purchased STATA 15 (the incumbent's new product) significantly more (at a significance level of 0.1) in low quality difference condition while they purchased STATA 12 (the incumbent's existing product) significantly more (at a significance level of 0.1) in high quality difference condition. There is no significant difference for SAP for high-low quality difference conditions. One possible interpretation of this result is that high quality difference is not convincing. When the subjects are informed that the new product is much better than the existing product, they don't believe that and choose to purchase the existing product. Another possible reason is that people may get afraid to adopt a much better product. There is no significant difference between early and late preannouncement conditions for any kind of product unlike what we expected.

With the thought of that preannouncement changes people's ideas, we analyzed the preferences of subjects who saw the incumbent firms preannouncement (the ones after Stage 2 for early preannouncement condition and the ones after Stage 4 for late preannouncement condition). The results and z-test are presented below.

Tab. 6.4: Experimental Results of the Subjects Who Saw the Incumbent's Preannouncement for STATA 12

|                       | STATA 12 buyer | STATA 12 non-buyer | Total |
|-----------------------|----------------|--------------------|-------|
| Early preannouncement | 9              | 14                 | 23    |
| Late preannouncement  | 1              | 16                 | 17    |
| Total                 | 10             | 30                 | 40    |

z-test for STATA 15:

$\pi_1$ : Number of purchases of STATA 12 in early preannouncement group

$\pi_2$ : Number of purchases of STATA 12 in late preannouncement group

$$H_0 : \pi_1 = \pi_2, H_1 : \pi_1 \neq \pi_2$$

$$p_1 = \frac{9}{23} \quad p_2 = \frac{1}{17} \quad p = \frac{n_1 p_1 + n_2 p_2}{n_1 + n_2} = \frac{10}{40} \quad s = \sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)} = 0.138 \quad z = \frac{p_1 - p_2}{s} = 2.39$$

Since  $2.39 > 1.96$  (1.96 is critical value at significance level 0.05), we reject  $H_0$ .

The results show that the subjects choose to purchase STATA 12 significantly more (at a significance level 0.05) in early preannouncement condition. One possible interpretation of this result is that the subjects get more impatient when they realize they will wait more for the new product that they prefer to buy the existing product.

Another point attracting our attention is that there are many subjects that bought the incumbent firms existing product in the first stage. We analyzed those who bought the product in the first stage and those who did not buy in the first stage using binary logistic regression in SPSS (1: the ones who bought in the first stage, 0: the ones who did not buy in the first stage). We took the stage as the dependent variable and experience (we asked them how experienced they think they are), academic grade (freshman, sophomore, junior, senior), being an exchange or not, age and gender as covariates. We chose experience and academic grade as variates because we thought these may affect the decision since the subject have more idea about the products in case he is more experienced or in higher classes. We chose being an exchange or not as a variate because we thought cultural differences may affect the decision. We found out that the more experienced the subject sees himself, the more likely he is to buy earlier. Likely, the higher class the subject is in, the more likely he is to buy earlier. Looking at the chi-square values, we can say that experience and academic grade have the most effective variables. A potential reason for this is more experienced students think that they need the product at the moment and the current product must be good enough for them. Being an exchange student or not and gender do not affect the results significantly. Likelihood ratio tests are shown in Figure 6.1.

Results show that the subjects more likely preferred to buy the existing product in the first stage instead of waiting the new product. This preference led them not to see the incumbents new product preannouncement. So, the experiment could not track how new information affected people properly. Other than that, the subjects preferred to buy the new product when the quality difference between the existing product and new product was lower and preferred to buy the existing product when the new product was preannounced earlier. These results conflict with the analytical findings. We think the main reason of that the experiment does not fully support the analytical model is because the subjects are not homogeneous. Our analytical model assumes that all the people are heterogeneous and an amount of them get affected in the same way with new information and only when there is new information. This means that there should be different customer types in the model. These types can be the customers who are willing to pay more for a better product, the customers who do not care about the brand name and want to buy an existing product immediately, the customers who do not trust in the preannouncements and only care about the products they can touch and so on. Besides, the experiment shows that the model assumptions are not true all the time. People in real life may change their purchasing ideas in the direction of needs even there is no new information in the market. People may be in urgent need and want to buy an available product immediately. These

| Likelihood Ratio Tests |                                    |                        |    |      |
|------------------------|------------------------------------|------------------------|----|------|
| Effect                 | Model Fitting Criteria             | Likelihood Ratio Tests |    |      |
|                        | -2 Log Likelihood of Reduced Model | Chi-Square             | df | Sig. |
| Intercept              | 256.815                            | 3.537                  | 5  | .618 |
| experience             | 262.386                            | 9.109                  | 5  | .105 |
| grade                  | 268.402                            | 15.125                 | 5  | .010 |
| exchange               | 257.480                            | 4.203                  | 5  | .521 |
| age                    | 259.867                            | 6.590                  | 5  | .253 |
| gender                 | 257.457                            | 4.179                  | 5  | .524 |

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

Fig. 6.1: Likelihood Ratio Test

findings lead us to the future research. We will include different customer types in the analytical models in our future work. Moreover, the assumptions should be updated in the light of experimental results. Another point is that a pre-experiment with manipulation check questions can be run to see whether the subjects understand the experiment in the right way or whether the words we use in the experiment point out the way we want.

## 7. CONCLUSION

New product preannouncement has been a popular marketing strategy lately. True usage of this strategy may be very beneficial for the companies. However, it may be harmful when the company cannot manage the process, as well. Early preannouncement may cannibalize the existing product while late preannouncement may not be as effective as expected. In this paper, we studied the optimal timing of preannouncement for an incumbent firm and an innovative firm. We analyzed the case for the incumbent firm in a monopolistic market as well as for the incumbent and the innovative firms in a duopolistic market with and without discounting factor and when the innovative firm is not reliable. Our findings show that there is unique optimal preannouncement strategy for a monopoly while there are thresholds in duopoly cases.

Firstly, the incumbent firm should preannounce immediately in a monopoly since the new product is more profitable than the existing product. The firm can convert more people to buy the new product by preannouncing earlier. The case gets more complicated in a duopoly. A new company preannounces a new product in this case. In the first sight, preannouncing immediately may seem attractive to the incumbent firm since its new product is more profitable. However, the analytical model shows that the incumbent firm should preannounce either immediately or at the same time as the innovator launches its new product. The strategy changes in the duopoly market because time dependent amount of customers convert to the innovative firm's product. When the incumbent firm preannounces early, it can convert less proportion of innovative firm waiting customers to its own new product. However, the same incumbent firm can convert more people to its more profitable new product. This conflict gives a threshold that the incumbent firm should preannounce either immediately or at the same time as the innovator launches its new product. Higher quality difference between the incumbent's existing product and the new product leads the company to preannounce immediately. Moreover, if the incumbent firm dominates the market (if less amount of people prefer to buy the innovative's product), it should preannounce the new product immediately, as well. These two points end up with the fact that the income from the incumbent's new product counteracts the loss from converting people. Preannouncing after the innovative firm launches its new product is never optimal because it is not possible to convert people who buy the innovator's product any more. In the same duopoly case, the unique preannouncement strategy for the innovative firm is preannouncing immediately since the case for this firm is monopoly with less amount of customers.

Secondly, we analyzed the case with the presence of discounting. In this case, the income from the existing product increases in time. So, cannibalizing this product is not as profitable as the case without discounting. Hence, the discounting factor takes the threshold backward. Higher quality difference between the incumbent's existing product and the new product leads the incumbent to preannounce immediately.

Thirdly, we analyzed the duopoly case with an unreliable innovative firm. In this case, there is probability that the innovative firm may not launch its new product. The presence of the unreliability factor takes the threshold forward meaning that the incumbent company more likely preannounces immediately with an unreliable rival. This is an expected result because when the innovative firm is unreliable, the case gets closer to the monopoly case in which preannouncing immediately is always optimal. Preannouncing after the period the innovative preannounces to launch its new product is never optimal for the incumbent to preannounce just like in the duopoly case.

Lastly, we ran an experiment to find out people's real decisions about the preannouncement. The experimental results didn't fully support the analytical model results. The results shows that people more likely prefer to buy an available product immediately when they need one. Lower quality change leads people more to wait for the new product. The reason may be high quality difference is not convincing or people do not want to adopt a higher change. Moreover, earlier preannouncement leads people to buy the existing product. The reason may be people do not want to wait for the new product when they are in need.

These experimental results motive us to the future work. We think that a customer type factor is missing in our analytical model since there is heterogeneity among people. The customers may want to pay more extra quality or not, they may care about the brand name or not, they may need a product at the moment and so on. We should include a probability that people may change their ideas without new information and this new information does not affect everyone in the same way and same amount since we saw that some of the subjects in the experiment bought a product in the period without new information.

Our findings still applicable for the preannouncement decisions on the market. For example, a software company that has a new rival can use the analytical model to decide on the preannouncement timing of its new product. Other than technology companies, any company that intend to launch a new product or service can decide whether to preannounce immediately or later. The companies should determine when the rival will launch its new product, what percent of the customers will convert to the rival and when its new product will be ready to be launched.

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## APPENDIX

## A. EXPERIMENT

Please start with reading the following text very carefully and imagine that you find yourself in the scenario as described:

You are starting a new academic year at Ko University, it is October 1st. As a Ko University student, you need to use statistical analysis software for your studies and research. You will be using this type of software in many of your classes, not only this year but also next year. You won't have any tutorials on how to use this type of software but statistical analysis software typically has very user-friendly manuals. Assume that you own a laptop but that you do not have this kind of software on it. You can access the statistical analysis software called STATA 2009 using the common computers on campus. STATA 2009 is the version that was introduced 6 years ago by STATA Company. One problem with using the software on the common computers is that in busy weeks it can be difficult to find an available common computer and you may waste time waiting. You have the alternative to buy a legal personal copy of statistical analysis software online for your own laptop.

STATA Company has been consistently launching updated versions of this software every 3 years since 1997. The current version on the market is STATA 2012 and it was introduced 3 years ago. STATA Company offers student price for STATA 2012 which is 49 TL. While both the 2009 and the 2012 versions have the functionality to complete your assignments and projects, STATA 2012 is slightly faster, includes a few additional analysis options, and it has slightly better graphics.

In what follows, we ask you what you plan to do (e.g. purchase a software package, not purchase) given the situation just described. You have to decide stage by stage what to do. The first stage will be October 1st 2014, and then follow a number of other stages which are 15 days apart (October 1st, October 15th, etc). The last stage will be December 1st. Keep in mind that your budget allows you to purchase at most one product in case you want to buy one.

1: (1 October 2014) Today, another software company called SAP Company has announced that they will offer statistical analysis software. It will be slightly faster, it will include a few more additional analysis options, and it will offer slightly better graphics than STATA 2012. This package is called SAP STAT. This is the first time that SAP Company introduces such software. SAP STAT will be available one month from now, on 1st of November, 2014. SAP Company announces that the interface of SAP STAT will be similar to STATA's interface and it will be equally user-friendly. Today, the only product on the market is STATA 2012. Please, indicate your decision for today:

I buy STATA 2012 for 49 TL

I don't buy a product

2: (15 October 2014) Today, STATA Company has announced that they will introduce an improved version of STATA 2012, named STATA 2015, on 1st of December, 2014. STATA 2015 will be slightly faster, it will include a few more additional analysis options, and it will offer slightly better graphics than STATA 2012. The interface and user-friendliness of STATA 2015 will remain unchanged. Today, the only product on the market is STATA 2012. Please, indicate your decision for today:

I buy STATA 2012 for 49 TL

I don't buy a product

3: (1 November 2014) Today, SAP Company has effectively launched SAP STAT. It is slightly faster, it includes a few more additional analysis options, and it offers slightly better graphics than STATA 2012. The interface of SAP STAT is similar to STATA's interface and it is equally user-friendly. SAP STAT costs 49 TL. Today, there are 2 products on the market: STATA 2012 and SAP STAT. Please, indicate your decision for today:

I buy STATA 2012 for 49 TL

I buy SAP STAT for 49 TL

I don't buy a product

4: (15 November 2014) You have no news today. There are 2 products on the market: STATA 2012 and SAP STAT. Please, indicate your decision for today:

I buy STATA 2012 for 49 TL

I buy SAP STAT for 49 TL

I don't buy a product

5: (1 December 2014- Last period) STATA Company has effectively launched STATA 2015. STATA 2012 has been taken off the market and is no longer available. STATA 2015 is slightly faster, it includes a few more additional analysis options, and it offers slightly better graphics than STATA 2012. STATA 2015 costs 59 TL. There are 2 products on the market now: STATA 2015 and SAP STAT. Please indicate your decision for today:

I buy STATA 2015 for 59 TL

I buy SAP STAT for 49 TL

I don't buy a product

Finally, please answer the following questions:

How much improvement do you think STATA has offered between STATA 2012 and STATA 2015?  
(Give a number between 1 and 7. 1 is very slight improvement, 7 is very big improvement)

1 2 3 4 5 6 7

Did you think SAP Company would launch the product on time?

Yes

No

What do you think about the quality of SAP STAT? (Give a number between 1 and 7. 1 is slightly better than STATA 2012, 7 is much better than STATA 2012)

1 2 3 4 5 6 7

How experienced are you with statistical tools? (1 is not knowledgeable at all, 7 is an expert)

1 2 3 4 5 6 7

What is your academic standing?

Freshman (Bachelor 1st year)

Sophomore (Bachelor 2nd year)

Junior (Bachelor 3rd year)

Senior (Bachelor 4th year)

Graduate

Are you an exchange student?

Yes

No

Age:

Gender:

Male

Female